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An Enhanced Smart Conveyor of Sequential System Zelio Smart Relay

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ABSTRACT

There are several ways to set up a single-lane conveyor that must serve the flow of goods (box cartons), especially with a sequential system, there are also sequential and magnetic systems. Both systems can actually run well, it's just that there are several obstacles faced. The obstacle in the sequential system is in the construction of a very complicated control system. The obstacle in the magnetic system is the problem of its arrangement, because if the conveyor setting is to be changed, then you have to come to the conveyor location. So there needs to be a solution for conveyor settings using Zelio Smart Relay (smart relay), by using this tool we are more precise in finding errors both in terms of the ledger diagram. Therefore, how great is the role and function of Zelio Smart Relay (smart relay), in the conveyor arrangement process that has been widely used by contractors in running their projects. project results both through education and training, scientific work meetings, mass media, electronic media, and others. One of the dissemination and use of the results of research projects is through education and training in the form of short courses according to the results of the research project itself. Likewise, it is important and necessary to have a professional organizer in managing the dictates and building the software and hardware so as to provide convenience for the contractors themselves.

Keywords: Conveyor, Zelio Smart Relay (intelligent relay), PLC, Logic gate.

1. INTRODUCTION

The development of the increasingly sophisticated era makes the tools that are created also better and more sophisticated, such as this conveyor. The history of conveyors or conveyor belts began in the second half of the 17th century. Since then, conveyor belts have become an inevitable part of material transportation. But it was in 1795 that conveyor belts or conveyors became a popular tool for conveying bulk materials. At first, conveyor belts were used only to move sacks of grain for short distances.

Conveyor is a mechanical system that has the function of moving goods from one place to another. Conveyors are widely used in industry for the transportation of goods in very large quantities and continuously. In certain conditions, conveyors are widely used because they have economic value compared to heavy transportation such as trucks and transport cars. Conveyors can mobilize goods in large quantities and continuously from one place to another. The transfer of the place must have a fixed location so that the conveyor system has economic value.

The weakness of this system is that it does not have flexibility when the location of the goods being mobilized is not fixed and the number of goods entering is not continuous. This also happens to the straight conveyor which will be forwarded to the loading section or pallet. Here often arises a problem, where the cartoon box is no longer delivered by the conveyor from the machine, then the conveyor will continue to run even though there are no more goods delivered by the conveyor. For that, a control system must be designed, and there needs to be an application of technology that can regulate the conveyor problem.

Zelio Smart Relay (smart relay) is a tool designed as a control system tool that can be programmed logically. Zelio Smart Relay (smart relay) works by observing input, then carrying out processes and taking actions according to needs, which are in the form of turning on and off the output. Users create programs that must then be run by Zelio Smart Relay (smart relay) according to the program.

The application of the use of Zelio Smart Relay (smart relay) as a programmed control tool and designed to be able to save conveyor usage. So that the problems that occur can be resolved properly.

2. LITERATURE

2.1. Conveyor

Conveyor is a mechanical system that has the function of moving goods from one place to another. Conveyors are widely used in industry for the transportation of goods in very large and continuous quantities.

In certain conditions, conveyors are widely used because they have economic value compared to heavy transportation such as trucks and transport cars. Conveyors can mobilize goods in large quantities and continuously from one place to another. The transfer of the place must have a fixed location so that the conveyor system has economic value. The weakness of this system is that it does not have flexibility when the location of the goods being mobilized is not fixed and the amount of goods entering is not continuous.

Conveyor specifications must also be adjusted to the dimensions and loads of the units to be transported. The design of the conveyor roller system must be able to accept the maximum load that may occur on the conveyor system. In addition, the design of the system dimensions must also be considered to match the dimensions of the units to be transported.

In some cases, the unit dimensions that are wider than the roller width dimensions are still allowed. The distance between the rollers is adjusted to the dimensions of the unit to be transported. It is recommended that the distance between the rollers be made as close as possible so that load support is increasing. In addition, the dimensions of the transported unit must be supported by at least 3 rollers. If less than 3 rollers, the unit will be stuck and can even fall out of the roller conveyor transportation system. The advantage of the roller conveyor is that it can transform at a certain slope so that the conveyor can transport goods from one level to another. In addition, the roller conveyor can also turn the path of the unit that has a very sharp bend. This is useful for areas with limited space.

In addition, roller conveyors have the ability to combine 2 separate paths. The combination of the 2 paths can be done using various methods such as Y-Line (line) and accumulation (collection) of roller conveyors. Here is a picture of a conveyor

Figure 1. Conveyor

The main components of the tools and functions in the roller conveyor system are as follows:

a Body Frame

The body frame has a function to support the roller so that the location of the roller does not move. The installation of the roller with the body frame must be fitting so that there is no unwanted vibration when the roller rotates. In addition, the body frame also determines the appropriate distance between the rollers so that the unit to be transported does not fall.

b. Poles

The support pole functions as the foundation for the roller conveyor system body frame. This body frame is designed as a support for the roller conveyor on the ground passed by the conveyor system.

c. Drive Motor

The drive motor has a function to drive the drive roller (drive roller) so that it always rotates according to the speed desired by the operator. This drive motor is generally placed at the very end of the conveyor roller groove (roller) in order to keep the transmission chain tense.

d. Roller(roller)

Roller(roller) has a function as a mover of goods to be transported. When the roller rotates, it is attempted not to vibrate so that not damage the goods being transported. The dimensions of the roller Roller (roller) must also be the same so that the goods being transported are not jammed and the Roller (roller) can support the goods perfectly. The roller in the Roller (roller) conveyor system has special attention because it is the most important component in this system. So the design and maintenance of the Roller (roller) must receive more attention. The following is the design of the roller conveyor components that have been analyzed in the Machine Design Assignment I course. The Roller (roller) components themselves consist of pipes, bearing housings, seals, shafts, snaprings, C-rings, and bearings.

e. Transmission System

The transmission system has a function to transmit power to the drive to the conveyor system. Transmission on the sister roller conveyor is divided into 2 parts, namely the transmission between the drive motor and the drive roller and the transmission between the drive roller and other rollers. The transmission system between the drive motor and the drive roller is usually placed at the very end of the conveyor line. This transmission system usually consists of a motor, speed reducer (speed measurement), coupling, sprocket, and chain. The transmission system between the drive roller and the roller is usually placed on the conveyor system body frame. Transmission between rollers usually uses sprockets and chains with a rotational speed ratio of 1: 1 so that the rotational speed between rollers is the same and the goods being transported can run smoothly.

2.2. Working mechanism

The general working mechanism of the roller conveyor is as follows:

a. The drive motor rotates the shaft on the motor which has a transmission system installed towards the drive roller.
b. The rotation of the shaft on the motor is transmitted to the drive roller through a transmission system that has been specially designed for the roller conveyor system.
c. *Drive roller*(drive roller) attached to the transmission system rotates due to the power transmitted by the transmission system.
d. *Drive roller*(drive roller) transmits the rotation of the roller to other rollers by chain transmission.
e. The rollers are given the same transmission path with a transmission ratio of 1:1 so that the rotation between the rollers has the same speed.
f. The transmission between the rollers is continued to the last roller.

In a production process in industry, there is often a need for quantities that require special conditions or requirements that can facilitate the achievement of production targets. These special requirements include high accuracy, constant values, for a certain time interval, a fixed number comparison between two variables/quantities or the existence of a quantity as a function of another quantity.

Control system in electrical engineering means a device or group of devices used to regulate the working function of a machine and map the working process of the machine as desired. The working function of the machine includes, among others, starting, regulating, and stopping a working process. In general, a control system is a collection of electrical or electronic equipment, mechanical equipment, and other equipment that ensures the stability and transition as well as the accuracy of a working process. The control system has three elements, namely input, process, and output.

Input(input) is generally a signal from a transducer, which is a device that can change physical quantities into electrical quantities, such as push buttons, limit switches, thermostats, and so on. The transducer provides information about the measured quantity, then this information is processed by the process section. The process section can be a control circuit that uses conventionally assembled equipment, or it can also be a programmable control system such as a PLC.

Processing of input signal information produces output signals which are then used to activate the output equipment actuators.

can be electric motors, contactors, solenoid valves, lights, and so on. With output equipment, electrical quantities are converted back into physical quantities.

The use of control systems can be found in everyday life, both in direct and indirect use. The use of this control system can be grouped into types of use for:

a. Process control, including control of temperature, pressure, liquid surface height and others.
b. Closed network systems and open network systems.
c. Power plant.
d. Transportation control such as elevators, escalators, conveyors and others.
e. Numerical control, such as controlling an operational process that requires high accuracy in repeated processes. For example, drilling, making a mall, and others.

2.3. Conventional Control System

The control process in industry is always evolving along with the increasing amount of production that must be produced. Machines used to carry out the production process in industry are generally driven by electric motors. The process of controlling machines driven by electric motors mostly uses switch-

es that are operated directly by human hands manually. This control process is less reliable and inflexible.

The manual control process (using ordinary switches) is starting to be abandoned and replaced with the use of electromagnetic switches or contactors. This tool can be operated with the use of relatively low electrical power to operate the working coil of the contactor.

The use of contactors is equipped with other components, such as push buttons, timers, Thermal Over Load (terminal overload) and other equipment that can be assembled in a distributed panel. However, in its development, electric motor control must be combined with more modern control tools with mechanical systems. Even at this time, the control system has used many electronic devices that can be programmed such as the use of Programmable Logic Controllers (programmable logic control).

2.4. PLC Control System

With the increasing development of technology, control tasks are made in the form of programmed control that can be done using, among others, PLC Programmable Logic Controller (programmable logic controller). With PLC, signals from various external equipment are interfaced so that they are flexible in realizing the control system. In addition, its ability in network communication allows for wide application in various system control operations.

In automation systems, PLC is the 'Heart' of the control system. With the program stored in the PLC memory, in its execution, the PLC can monitor the state of the system through signals from input devices, then based on the logic of the program determines the series of control actions of external output devices. PLCs can be used to control simple, repetitive tasks, or interconnected with others using computers through a type of communication network to integrate complex process control.

Programmable logic controller (programmable logic control) abbreviated as PLC is a special form of microprocessor-based control device. Utilizing programmable memory to store instructions and use functions such as logic, sequential, timing, counting, and arithmetic to control machines.

This equipment is designed in such a way that not only programmers can create or change the program. Therefore, the design of the PLC places an initial program in the device that allows the control program to be entered using a simple form of programming language.

The term logic is used because the programming that must be done is mostly related to the use of logic operations and switching connections. Input devices such as sensors, switches, and output devices in the controlled system such as motors, solenoid valves, and so on are connected to the PLC. Then the instructions are input in the form of a program. The controller device then monitors the input and output. according to the instructions in the program and implementing the programmed control rules.

PLC has significant advantages, because an adaptable control device is used in various systems. To modify a control system and the control rules that are run, then it is sufficient to configure the existing program or change the entire existing program. Without replacing the circuit, thus producing a flexible and efficient device.

2.5. PLC Working Principle

There are three main components that make up a PLC, namely: Central Processing Unit (CPU), input / output, and programming device. As illustrated in block diagram 2.16. While other components are such as: power supply (resource), recorder player / tape or disk, optional remote interconnection and optional remote master computer. CPU works based on microprocessor that works to replace relay function, counter (counter), timer (timer), and sequences (sequence). Therefore,

programmer can create circuit that uses relay function above

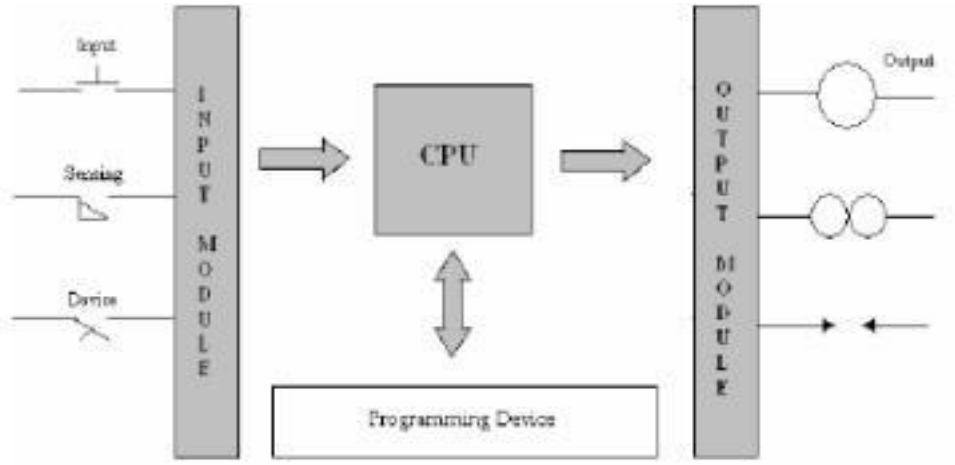

Figure 2. PLC part

3. METHOD

Zelio soft 2 program is a software to create a Zelio smart relay PLC program. This software is quite easy to use and easy to understand. Zelio soft 2 can be programmed with two methods, namely with a ladder diagram (LAD) or Function Block Diagram (FBD). In addition, this software also provides 2 displays, namely Electric symbol and Ladder symbol and with this software we can simulate the results of the program we created before trying it on the PLC tool.

Communication between computers and controlled equipment is an absolute requirement that must be met in a data communication system to be able to communicate between computers and PLCs, there needs to be settings or adjustments to suit the computer used. In this case, the discussion is how to create a basic program using the Zelio Soft 2 program with a ladder diagram.

The PLC trainer used is the SR3B261BD type consisting of 10 discrete inputs, 6 analog inputs, and 10 output relays. If the PLC is another type, just adjust the appropriate steps. Before using this PLC, the computer must have a Zelio Logic PLC program such as using Zelio Soft 2 software. The first time the Zelio Soft program is run, a window display like this will appear following:

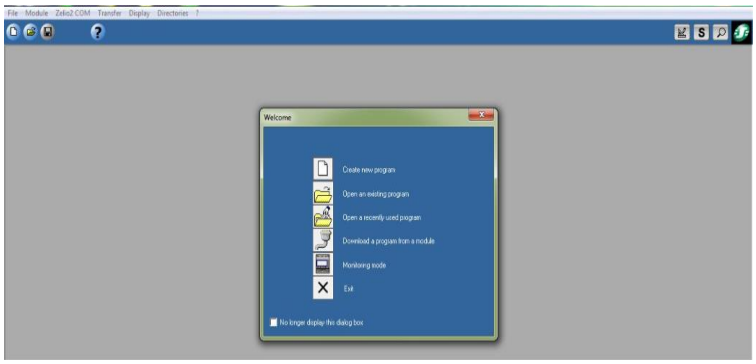

Figure 3. New program view

From the window above, select created new program or select new on the file menu that has been displayed. Then a new window will appear containing smart relay options as follows.

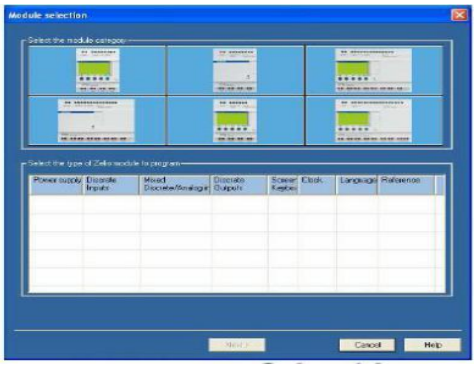

Figure 4. New Program display

Then select the SR3B261BD module, this module consists of 10 discrete inputs, 6 analog inputs, and 10 output relays and has a supply voltage of 24 volts.

If you have selected, the yellow background on the selected module will appear, then select the next menu, the module extension specifications that are compatible with the Zelio Smart module that will be used will appear.

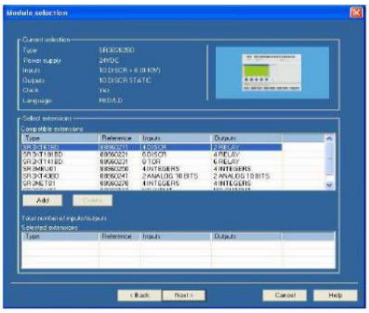

Figure 5. Selected Zelio

Then select next on the screen so that a new window appears displaying the options in the form of the desired program input. Zelio Logic provides two programming options, namely ladder and function block diagram.

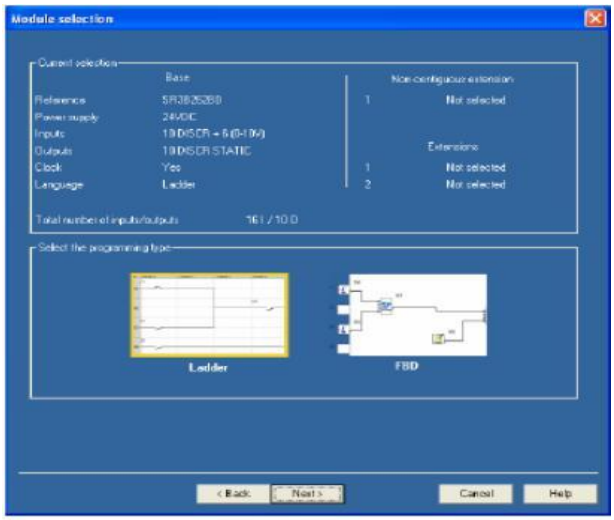

Figure 6. Program Selection

Then select ladder programming as the default input type for the program and it is marked with a yellow border line.

4. RESULTS AND DISCUSSION

4.1 Control System Analysis

Based on the simulation that has been tried and run, the analysis results of the sequential conveyor automation control system using Zelio smart relay (smart relay) are obtained, where the control system to be analyzed is the control system before being simulated using the Zelio soft 2 program. and the results of the analysis of the sequential conveyor automation control system using Zelio smart relay (smart relay) are as follows.

- The first motor moves as the first conveyor driver that delivers goods to the next conveyor with a Timer interval (timer) 1 which works after pressing the ON button.

- Motor 2 will work and move conveyor 2 after the goods on conveyor 1 are detected by sensor (1) which functions as a switch (to switch) the motor 2 drive, where sensor 1 is located at the end of conveyor 1.
- Likewise, Motor 3 will work and move conveyor 3 after the goods on conveyor 2 are detected by sensor (2) which functions as a switch (to switch) the motor 3 drive, where sensor (2) is located at the end of conveyor 2.
- All motors will stop after there are no more goods flowing on the conveyor, this is because timers 2, 3 and 4 work to disconnect the system connection control on motors 3,2, and 1 so that the conveyor is turned OFF sequentially automatic.
- And this control system will repeat its working system again if the On button is pressed again for the command to run the conveyor sequentially.

4.2. Analysis Results Table Before Simulation

Table 1. Detected Item Analysis Results

Detected Item Analysis Results			
Specifications	**Motor 1**	**Motor 2**	**Motor 3**
ON/OFF	ON		
sensor 1		Detected	
sensor 2			Detected
Timer 1	Work		
Timer 2			
Timer 3			
Timer 4			
conveyor 1	Move		
conveyor 2		Move	
conveyor 3			Move
Source: Author, laptop 2021.			

Table 2. Results of Analysis of Undetected Goods

Undetected Item Analysis Results				
Specifications	**Working / stopping**	**Motor 1**	**Motor 2**	**Motor 3**
Timer 2	Work			Stop
Timer 3	Work		Stop	
Timer 4	Work	Stop		

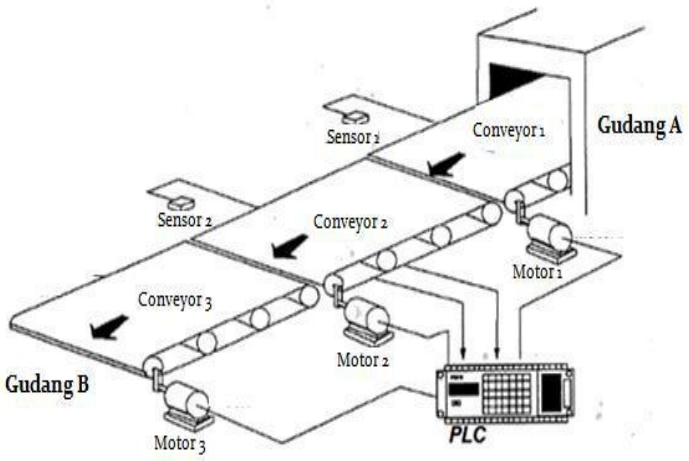

Figure 7. Conveyor Control.

After conducting the control system analysis, the next step is to analyze the sequential conveyor automation control system program using the Zelio Soft 2 software program. The analysis that can be analyzed on the sequential conveyor automation control system using the Zelio Soft 2 software program is as follows.

- In the sequential conveyor control system program using Zelio Smart Relay (intelligent relay) with Zelio Soft 2 software, I1 I2 and I3 as input for the OFF, RESET and ON push buttons.
- Meanwhile, sensor 1 is I4 and sensor 2 is I5, this is intended as input to control the start and stop of the conveyor motor.
- *Timer*(timer) as a delay timer to start motor 1, in the program the input TT1 is given, and to disconnect the control connection in motors 1, 2 and 3 in the program the input TT2 (20s), TT3 (10s), and TT4 (10s) are given and the time is set in seconds, but this time setting can be changed if the time limit is not enough or is excessive.
- Q1 as the first coil that is given input as a Timer driver (timer regulator). After a time interval of 5 seconds, motor 1 will run.
- Q2 as the second coil that is given input from the command of motor 1 which is already ON delay (delay) after 5 seconds, Q2 will drive motor 1 to deliver goods to the next conveyor. After the goods are detected by sensor 1 which is given input I4 as a switch (switching) the motor 2 (Q3) drive
- Then Q3 as the third coil that is given input from the motor 2 command that is already ON because of sensor 1 (I4), Q3 will drive motor 2 to deliver goods to the next conveyor. After the goods are detected by sensor 2 which is given input I5 as a switch to drive motor 3 (Q4).
- All motors will stop after there are no more goods flowing on the conveyor, this is because timers 2, 3 and 4 work to disconnect the control system connection in motors 3, 2 and 1 so that the conveyor turns OFF sequentially automatically.
- And this control system can be repeated, when you want to run it automatically again and here is the automatic sequential conveyor control system using Zelio smart Relay (smart relay) which is simulated using the Zelio soft 2 program.

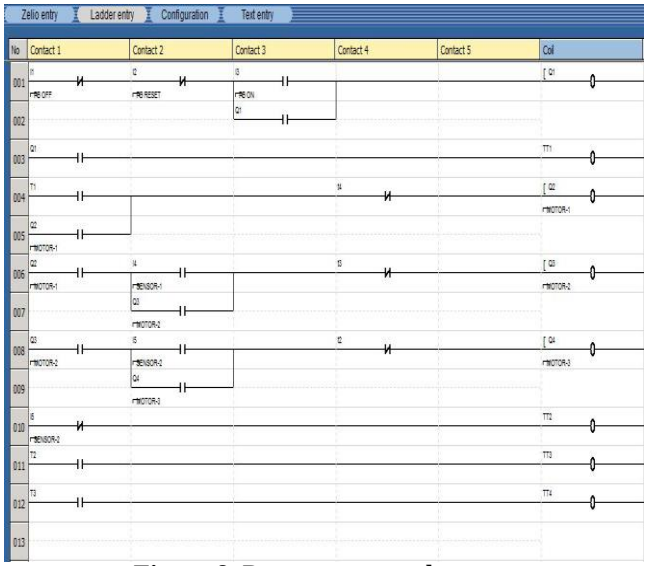

Figure 8. Program control system

The flowchart below can also be used as a reference for analyzing the sequential conveyor automation control system using the Zelio Smart Relay which is simulated in the Zelio Soft 2 program. Where this can analyze the working system of the program control system, which is in accordance with the circuit that has been created and simulated.

Table 3. Input Code Table

Tabel Kode Timer		
Kode Timer	Keterangan	Pengaturan
TT1	Timer 1	5/s
TT2	Timer 2	20/s
TT3	Timer 3	10/s
TT4	Timer 4	10/s

Table 4. Timer Code Table

Tabel Kode Input	
kode input	Keterangan
I1	OFF
I2	RESET
I3	ON
I4	SENSOR 1
I5	SENSOR 2

CONCLUSION

Based on the results of experiments, tests and analysis that have been carried out during the writing of this thesis, it was concluded that:

1. After conducting a control system simulation using Zelio Smart Relay, it was found that the sequential conveyor working system is very concise and easy.
2. Zelio Smart Relay through sensors will automatically turn on other conveyor motors and there is no need to add another control system to turn on the conveyor.
3. Zelio Smart Relay through a timer designed in a series will stop the entire conveyor working in a sequential system, starting from conveyor 03, conveyor 02, and then conveyor 01.
4. The results of the comparison before this control system was designed with the previous one, make it easier for machine operators and owners to save electricity used for the voltage of this conveyor if there is no more production.
5. The ongoing operation process can be monitored to find out the up to date conditions errors that occur can be identified quickly.

Declaration by Authors

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